Adaptation to flood risk: the case of businesses in the UK

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Abstract

Despite Government investment in flood defence schemes, many properties remain at high risk of flooding. A substantial portion of these properties are business establishments. Flooding can create serious consequences for businesses, including damage to property and stocks, being out of business for a considerable period and ultimately business failure. Recent flood events such as those in 2007 and 2009 that affected many parts of the UK have helped to establish the true costs of flooding to businesses. This greater understanding of the risks to businesses has heightened the need for business owners to adapt their businesses to the threat of future flooding. Government policy has now shifted away from investment in engineered flood defences, towards encouraging the uptake of property level flood resistance and resilience measures by businesses. However, implementing such adaptation strategies remains a challenge due a range of reasons. A review of the current state of property level flood risk adaptation of UK businesses is presented, drawing from extant literature. Barriers that may hinder the uptake of property level adaptation by businesses are revealed and drivers that may enhance uptake and effectively overcome these barriers are also discussed. It is concluded that the professions from the construction sector have the potential to contribute towards the adaptation of business properties and thereby the flood resilience of businesses at risk of flooding.

Keywords: Adaptation, Businesses, Flood risk, Resilience, Resistance

1. Introduction

According to the Environment Agency (2009), 5.2million properties in England; amounting to one in six, are currently at risk of flooding. Of these, 2.4million are at risk of river and coastal flooding and 3.8million are at risk of surface water flooding, and about 1million properties are at risk of flooding from both of the sources. Whilst community level strategic flood risk management strategies attempt to reduce the risk of flooding to these properties; especially the ones located in high flood risk areas, some properties may still be left without adequate protection. A significant portion of these properties that are at risk of flooding can be expected to be business establishments. For a business organisation, flooding can create serious consequences, including damage to property and stocks, being out of business for a considerable period of time and even ultimate business failure. Given that recent flood events such as flooding in 2007 and Cumbria floods in 2009 have well established how costly flooding can be (Pitt, 2008, ABI, 2010) to a business organisation, there is a significant importance in improving the flood risk adaptation of businesses at risk.

Adaptation as a term has been used in a range of subject localities including natural and social sciences. However, much of the focus on recent times has been on its use in relation to climate change. Many of the related definitions; for instance Pielke (1998), Smit et al (1999), Parry et al (2007) and UNISDR (2009), have identified adaptation as 'adjustment' of a certain system in response to the changing climatic conditions. Smit et al (2001) identified a range of adaptation categories based on different differentiating concepts including purposefulness, timing, temporal and spatial scope, functions/effects, form and performance. As discussed by Smit et al (2001), adaptation takes place in a dynamic social, economic, technological, biophysical, and political context that changes over time, location, and sector. Previous research on adaptation, especially from a climate change perspective, has identified that adaptation is determined by a range of factors. For instance, collective action and social capital (Adger, 2003), risk perception and perceived adaptive capacity (Grothmann and Patt, 2005), political and economic interests (Næss et al., 2005), nature of the hazards and their timescales (Brooks, 2003). Whilst many of the studies addressing adaptation has focused on long term climate change, the importance of adapting to short term climate stimuli such as extreme weather and flooding is also recognised. For instance, one of the principals of the adaptation policy framework developed by Spanger-Siegfried et al (2004; pp10) is that "adaptation to short-term climate variability and extreme events serves as a starting point for reducing vulnerability to longer-term climate change". The need for adaptation to flood risk can thus be realised both as a response to an immediate natural hazard which has caused considerable disruption to UK businesses over the years and also as a response to predicted long-term increase of flood risk induced by climate change.

Adaptation of business organisations to flood risk; in particular at the property level, is not always straight forward. Many factors are likely to influence the processes of decision making and implementing, as barriers and drivers. Some of these can be expected to be common to adaptation of businesses in general, whereas some may be specific to flood risk. Based on a systematic critique of the extant literature, this study identifies and discusses the barriers and drivers to property level adaptation of businesses to flood risk, as part of a wider study supported by the RICS Education Trust, to identify good practice in the context of flood risk adaptation of businesses.

2. Adaptation in the context of businesses

Adger (2000) defined institutional adaptation as "the net outcome of the evolution of institutions within the wider social environment along with institutional inertia", from the perspective of adaptation to environment risk. The term institutions here includes "both socialised ways of interacting and underlying worldviews, as well as structures and organisations that influence resource allocation" (Adger, 2000). Adger (2000) argued that the adaptation of organisations can be observed by actual resource allocations, processes of decision making and non decision making, and changing perceptions of vulnerability. From a climate change perspective, Bleda and Shackley (2008) identified adaptation as "the response to the impacts of both 'physical' events (precipitation, floods, droughts, etc.) and to changes in the organisation's institutional environment brought about by climate change (e.g. changes in mitigation policies, in media trends, or in the scientific community's perspective on climate change). The definition attempts to address adaptation of organisations to climate change impacts both in their physical and institutional environments. Bleda and Shackley (2008) identified belief in climate change and the risks involved as major factors affecting organisational adaptation.

From an organisational perspective, Brouillette and Quarantelli (1969), in their study of how bureaucratic organisations adapt to organisational stress (in a disaster) identified adaptation as a function of four internal factors; nature of demands as perceived by organisational personnel, bureaucratic structure, emergency capability, and perceived effectiveness and efficiency of emergency response. They suggested that external factors such as situational factors, space-time dimension, inter-organisational relationships, community context, and societal context as having an impact on organisational adaptation. Accordingly, four types of adaptation were identified; ongoing structure and tasks, new tasks, new structure, and new structure and tasks. The study looked as adaptation of bureaucratic organisations, hence the structure of organisations and tasks were the main issues considered. A matrix of structure and tasks was used to present the four types of adaptation. This structure was further developed by Bardo (1978), where 9 types of organisational response to disaster was identified based on structure and functions. Berkhout et al (2004) following their study of businesses and climate change concluded that adaptation as a process that can be characterised as:

- motivated by both direct and indirect signals
- based on both internal capabilities of the firm, as well as the regulatory, market and climatic context within which it operates
- involving poorly-defined choices between complex sets of measures, often made up of chains of adjustments that may involve several actors
- including the implementation of both anticipatory and reactive measures
- involving a variety of risk management strategies, including risk bearing, risk sharing, risk shifting and risk avoiding

Consequently, Berkhout et al (2004) discussed four modes of organisational adaptation; commercial adaptation – changes to commercial strategy of a business; technological adaptation – changes to technologies used in a business to provide products and services; financial adaptation – changes to financial management system; information and monitoring - changes in trends of gathering

information and monitoring. Berkhout et al (2004) observed four alternative adaptation strategies among businesses. These are “wait and see”, “risk assessment and options appraisal”, “bearing and managing risks”, and “sharing and shifting risks”. “Wait and see” is a deferral strategy, where the organisation will delay adaptation based on sceptism or uncertainty related to climate change. Organisation assesses different adaptation options available in “Risk assessment and options appraisal”. Bearing and managing risks is a strategy where the risks and opportunities arising from climate change are managed using existing organisational resources and capabilities. In “Sharing and shifting risks”, organisation attempts to transfer risks to external parties via approaches such as obtaining insurance. Therefore, organisations were perceived to have four alternative adaptation strategies available for each “mode” of organisational adaptation. Current evidence on adaptation of businesses to weather extremes such as flooding (Tierney and Dahlhamer, 1996, Crichton, 2006, Yoshida and Deyle, 2005, Alesch et al., 2001, Dlugolecki, 2008) seem to suggest that they are often limited to “wait and see” strategy, as many businesses were found without adequate coping strategies in recent studies.

Berkhout et al (2006) identified core competencies, core business, dynamic capabilities, and organisational culture as the factors that affect organisations’ approach towards an adaptation strategy. Yoshida and Deyle (2005) classified factors affecting small business hazard mitigation in to 4 main categories; characteristics of the businesses and the buildings within which they are located, hazards knowledge and experience of business owners and managers, access to technical knowledge about mitigation alternatives, and perceptions of the costs and benefits of alternative mitigation measures. Their empirical research identified that access to expertise, type of business, and perceived exposure of the business location to natural hazards as major factors affecting mitigation. Although the term “mitigation” was used in the study of Yoshida and Deyle (2005), the term has been used as a synonym for the term adaptation, rather than to mean mitigation as used in climate change literature.

Another perspective was provided by Mendelsohn (2000) who argued that businesses in certain sectors; farming, forestry, recreation, and energy, as more likely to engage in adaptation to climate change than businesses in other sectors. He identified two types of adaptation; private and joint. Private adaptation “is a behavioural response by an individual or a firm to an environmental change for one’s own benefit”, whereas Joint adaptation deriving benefits to many beneficiaries (Mendelsohn, 2000). In case of flood risk, adaptation of a businesses’ property to flooding can be identified as private adaptation, whereas a local flood alleviation scheme can be identified as joint adaptation. It was argued that individuals and firms are likely to adopt efficient adaptation (where benefits exceed costs), for their own good. In particular, it was proposed that no public policy is required to promote private adaptation, as this is driven by individuals’ or firm’s own benefits. Government action was identified as required in relation to externalities involved, information requirements and equity, in relation to private adaptation. Although this argument is logical, it does not seem to be fully realisable in a real world context, due to factors restricting organisational adaptation such as resource constraints and overriding priorities for businesses.

3. Adaptation to flood risk

Issues related to flood risk adaptation of businesses in the UK seems to have subjected to little academic research until recently. However, wide scale floods that affected the UK in recent years; for instance 2004, 2005, 2007 and 2009, and the significant disruptions experienced by businesses consequently, coupled with predictions that climate change is likely to increase such flood events, seems to have contributed to considerable attention being paid towards this aspect. Perhaps in one of the leading studies (Jones and Ingirige, 2008) that looked at how businesses in the UK respond to flood risk, Crichton (2006) found that 70% of businesses in high risk areas were not concerned that flooding might affect them. Further, a similar percentage of businesses were found to have no form of business continuity plan in place, in the event they are flooded. These two figures summarise the level of concern of UK businesses on flood risk and adaptation. It has to be noted that this is not limited to the UK context alone, but has been observed in other contexts; for instance Germany (Kreibich et al., 2008, Kreibich et al., 2007), France (Pivot and Martin, 2002), Australia (Gissing et al., 2005), and USA (Tierney, 1994) as well; where businesses were found to be less concerned about flood risk adaptation.

Kreibich et al (2008) in their study of flood affected companies in Saxony, Germany identified that relocation of utilities and hazardous substances to upper floors of buildings, flood proofed tanks and air-conditioning, adapted use of property, water barriers, and adapted building structure as the common property level flood protection strategies implemented by businesses. Flood insurance, emergency plans, and emergency exercises were other strategies commonly implemented by businesses. Crichton (2006) identified that home or flexible working, commercial insurance, reviewing risks to the premises, obtaining more advice and considering moving elsewhere as actions that UK small businesses were willing to implement to cope with the risk of flooding. In addition to such generic strategies, some businesses with previous flood experiences have implemented various strategies specific to their business. Such strategies include, restaurants with fryers set on a hydraulic system enabling the fryer to rise up above the water level, fridges made out of stainless steel with the motors set at the top, and water sealed ventilation systems (ODPM, 2003).

From the above evidence it can be noted that some businesses are active in implementing adaptation options while others are not. This can be due to many reasons. Kreibich et al (2007) noted differences in flood preparedness of businesses based on industrial sector, flood experience and knowledge, size of businesses, and building ownership. Early warning was identified as an important factor affecting emergency responses in a flood event. They also noted an increase in flood preparedness of businesses after being affected by a flood event, more in property level protection measures than behavioural precautionary measures. Similarly, a study conducted on behalf of Yorkshire Forward (EKOS Consulting (UK) Ltd, 2008) identified increases in flood preparedness activities of businesses affected by flooding. However, citing Barter (2002), Crichton (2005) declared that only a few small businesses had installed flood protection measures even after being flooded. He attributed this mainly to the type of property ownership of small businesses; which are likely to be based in leased properties, rather than in freehold properties.

4. Property level adaptation to flood risk

Although community-level structural flood protection schemes attempt to significantly reduce the risk of flooding in high flood risk areas, some of the properties may still be left without adequate protection. This is because it is neither possible nor economical to completely protect all the properties from flood risk (Thurston et al., 2008). This has led to an increased need for implementing strategies for property level flood protection, in order to improve their capacity to survive a flood event. However, according to Crichton (2006), businesses are likely to implement various generic coping strategies that aid business continuity, rather than property level adaptation strategies against flooding. This is in line with what Berkhout et al (2004) discussed in relation to climate change, where instances of adaptation to climate change were noted in businesses, which have been implemented due to commercial purposes rather than having climate change in mind. However, as generic strategies for business continuity can only limit adverse consequences on a flood hit business and aid recovery process; rather than preventing/limiting damage to property and its contents, some form of property level protection is desirable if a business is located in a high flood risk area. A report on businesses in Cumbria (BMG Research, 2011) affected by 2009 flooding found that more than half of the businesses (52%) that moved to temporary premises; as their premises were flooded, have not returned to the original premises even after 6 months from the event. This alone suggests how long it can take for a flooded property to be reinstated and, thus, how important it is to have property level protection measures in place, in order to minimise damages and aid quick recovery.

Property level flood protection measures can be either resistant or resilient (Bowker et al., 2007). Resistant measures attempt to prevent flood waters entering the property, whereas resilient measures attempt to minimise the impact of flood waters on property (Bowker et al., 2007). As far as businesses are concerned, one of the recommendations of the Pitt Review (2008) was to promote business continuity by encouraging the uptake of property level flood resistance and resilience measures by businesses. Further, Pitt Review (Pitt, 2008) recommended building regulations to be revised to ensure new and refurbished buildings in high flood risk areas are flood resistant or resilient. Although availability of information, guidance and standards on property level protection measures against flooding for existing as well as new buildings have seen an influx over the years, implementation of such strategies still seems to remain quite low. This can be attributed to presence of various barriers that hinder such implementation by businesses. Lamond and Proverbs (2009) discussed barriers and drivers that exist to implementation of structural adaptation to buildings by property owners. Consequently, barriers were classified in to 4 types; financial constraints, information barriers, emotional constraints, and timing sensitivity. It was thought that property owners should have both desire and ability to implement adaptation measures. Awareness, perceptions and ownership of the issue were thought at integral components of desire whereas knowledge, resources and belief were considered as components of ability. Following section seeks to discuss potential barriers and drivers for flood risk adaptation of businesses; particularly adaptation of their properties, from the extant literature.

4.1 Drivers and barriers to property level adaptation

An Australian study on flood preparedness of businesses (Gissing et al., 2005) identified four main barriers and drivers for preparedness. Preparedness here has been identified in terms of having equipment or procedures for specific flood response actions. Barriers identified were; Scepticism, trust (trust of state emergency services), self-confidence (confidence that the business can respond to a flood event even without prior planning) and time (lack of time for flood planning). It was identified that many businesses were sceptic about the probability of flooding as well as the losses that flooding can cause to businesses. Financial impacts, ownership, operational health and safety obligations and the business norms (role of business support organisations) were identified as the main drivers or motivators for flood preparedness.

Previous research in the UK and elsewhere has identified business size and previous flooding experience as two factors that affect the preparedness of businesses (Dahlhamer and D'Souza, 1997, Crichton, 2006, Kreibich et al., 2007, Kreibich et al., 2010). Hence, these can be identified as both barriers and drivers for adaptation. For instance, presence of a larger proportion of smaller businesses and no previous flood experience (although being located in a high flood risk zone) could act as barriers for adaptation. Consequently, larger businesses and business with previous flooding experience can be initially targeted for adaptation. In fact, Thurston et al (2008) identified that previous flood experience act as a factor affecting the implementation of property level flood protection measures.

Research by Environment Agency (EA) and Department for Environment, Food and Rural Affairs (DEFRA) (Thurston et al., 2008) identified that a full package of property level flood resistance measures is economically beneficial for a business if the risk of flooding is greater than 4% (25 year return period), whereas a package of property level resilience measures is beneficial if the risk of flooding is greater than 10% (10 year return period). Hence, economical aspect of the costs and benefit of adaptation was identified as a significant driver / barrier for adaptation.

Table 1 - Economic benefit-cost ratios for the use of different packages of mitigation (Thurston et al., 2008)

Annual chance of flooding	*Return frequency (years)*	*Resistance measures*		*Resilience measures*		*Resilient repair*	
		Temporary	*Permanent*	*without resilient flooring*	*With resilient flooring*	*without resilient flooring*	*With resilient flooring*
20%	*5*	*7.2*	*9.0*	*4.2*	*3.9*	*4.7*	*4.5*
10%	*12*	*3.9*	*4.7*	*2.2*	*2.1*	*2.5*	*2.4*
4%	*25*	*1.8*	*2.1*	*1.1*	*1.0*	*1.2*	*1.1*
2%	*50*	*0.7*	*0.9*	*0.5*	*0.4*	*0.5*	*0.5*
1%	*100*	*0.2*	*0.2*	*0.1*	*0.1*	*0.1*	*0.1*

In addition to the economical aspect, the study identified several other factors that act as barriers and drivers for adaptation. It was identified that the perceptions that such measures are expensive or not their responsibility act as barriers for adaptation. Some businesses believed that agencies responsible for managing the flood risk had implemented adequate mitigation actions and that therefore no individual action was required. General lack of awareness of options available and which option to be used were two main barriers identified. Some businesses were of the point of view that they would still be able to continue their business uninterrupted even if the business premises were flooded, leading to reduced implementation of protection measures. Perception that they are covered by insurance was another barrier for adaptation. Property ownership can also be a barrier / driver for adaptation. Dahlhamer and D'Souza (1997) identified property ownership as a significant factor affecting the flood preparedness of businesses in their study of US businesses. Property ownership can be expected to play an even more significant role when it comes to property level adaptation. Businesses who own the property can be expected to engage more in adaptation whereas a lower level of adaptation has to be expected from lessees and renters.

Insurance can be identified as a significant driver for adaptation. Crichton (2008) discussed that insurers can aid adaptation by promoting resilient reinstatement techniques and temporary defence solutions. More importantly insurers can act as a driver for adaptation of property level protection measures in insurance premiums. The Association of British Insurance too declared that the "premiums charged and policy terms will reflect the level of risk presented" in the case of flood insurance (ABI, 2008). Especially the businesses that have been affected by flooding previously have experienced increases in their insurance premiums. For instance, a study on businesses affected by 2007 summer floods in Yorkshire revealed that more than 50% of small businesses and more than 80% of medium and large businesses have experienced higher insurance premiums following the floods (EKOS Consulting (UK) Ltd, 2008). If the premiums will reflect the property level protection measures; i.e. if the premium is reduced when a business implements coping strategies, this will be a significant driver for adaptation for businesses. Conversely, increased premiums may lead businesses; especially small businesses, to undervalue their property, reducing the amount of damages that can be claimed if affected by flooding. For instance, AXA Insurance (2008) claimed that 90% of small businesses are underinsured for their building insurance cover. In addition to the costs of higher premiums, this might cause another severe risk to businesses. As the costs are high, they may tend to underinsure their assets, opt out of insurance or deny insurance, leaving them vulnerable to further losses in case of flooding, hence creating a vicious cycle. Small businesses, in which the power of negotiation is less when compared with large-scale organisations, may have to suffer losses because of these reasons. ABI identified "financial inclusion to make insurance more available" as one of the objectives of their climate change adaptation strategy in the UK (ABI, 2009). Insurance may increasingly be seen as unaffordable by small businesses, if such initiatives are not implemented.

5. Discussion

The above discussion indicates that adaptation can be categorised based on concepts such as purposefulness, timing, functions/effects, form and performance. Organisational adaptation to flood risk mainly seems to be responsive and reactive when concerning the timing aspect. Purpose wise, business organisations are likely to opt for commercially and economically beneficial adaptation

strategies. For example, Crichton (2006) identified that businesses were willing to implement various generic coping strategies, rather than property level adaptation strategies against flooding. On a similar note, Berkhout et al (2004) mentioned that businesses are likely to implement commercial adaptation strategies; implemented mainly having commercial benefits in mind which might lead to increased flood resilience, rather than specific property level adaptation strategies, unless they are impacted by flooding. Businesses previously affected by flooding seem to be the ones likely to implement property level coping strategies.

The notion that private adaptation will be undertaken by businesses rationally does not seem to be fully realisable in relation to property level flood risk adaptation. This is supported by the fact that some businesses were observed without adaptive strategies even after being directly affected by flooding. For example, Kreibich et al (2007), Molino and Gissing (2005) observed that some businesses were inactive in implementing measures against flood risk even after being affected. Such behaviour is likely to be observed in small businesses which by definition are limited in resources. Bichard and Kazmierczak (2010) noted that reward-based strategies lead to increased implementation of flood protection strategies by households. A similar approach, where businesses are granted commercial concessions/ rewards might be the way forward in increasing the uptake of flood protection measures by businesses.

Insurance seem to act both as a driver as well as a barrier for flood adaptation of businesses. With regard to insurance against flooding, the UK is in a unique situation where cover against flooding is provided as a part of standard property insurance. Hence, flood risk is likely to have a considerable impact on property insurance premiums. If implementing adaptive strategies would lead to lower insurance premiums, this would act as a driver for adaptation, whereas high insurance premiums may prompt business to under insure or opt out of insurance. This suggests that some sources such as insurers and loss adjusters can act as catalysts for property level flood risk adaptation of businesses. A study on how accountants can aid UK small businesses to adapt to weather extremes (Emissions Strategy Solutions, 2011) found that accountants could be a potentially effective source in raising the adaptive capacity of small businesses. The study found that while providing advice on being resilient to weather extremes could be a potential income source for accountants and a value addition for their service, it also led to businesses being more proactive in being weather resilient.

A similar tendency can be expected with other potential sources that interact with businesses, especially in relation to building and construction. The role of building and construction related disciplines in realising a resilient built environment is important (Bosher et al., 2007, Haigh and Amaratunga, 2010) and the same is likely to apply in case of adaptation of business properties. Flood protection, renovation and reinstatement can offer business opportunities to such disciplines whilst contributing towards effective adaptation of businesses. For instance, chartered surveyors could be an effective source in providing such advice to businesses. This requires building up capabilities and capacities of surveyors in order for them to be able to provide independent, reliable and valid advice on property level flood adaptation measures to businesses. It is important that such disciplines take in to account the factors that affect effective implementation of adaptation options by businesses, in recommending solutions to them. One way of identifying these would be by evaluating good practice in the adaptation of businesses to flood risk. These issues are currently being investigated by the

authors as part of an ongoing study to identify good practice in the context of flood risk adaptation of businesses.

6. Conclusions

As practical and economical reasons do not warrant complete protection of all the areas at risk of flooding by means of community level structural flood protection schemes, property level adaptation becomes a necessity, if the properties left unprotected by such local structural protection schemes are to be protected from flooding. Whilst there is evidence that some businesses have implemented such adaptation strategies, this seems confined to only a limited proportion of businesses at risk. Reasons for this could be manifold, as discussed in previous sections. It is important that barriers that hinder adaptation are addressed and drivers that promote adaptation are utilised when targeting policy, advice and guidance on property level flood adaptation aimed at businesses.

Providing businesses with relevant information, guidance and advice can be identified as critical in enhancing their adaptation to flood risk. Professions that interact with businesses in relation to flood protection have a crucial role to play in this regard. As part of a research study funded by RICS Education Trust in the UK, it is sought to investigate how surveyors can effectively provide such advice to businesses. The research seeks to build on evidence on property level adaptation of businesses and good practice, leading to greater understanding of facts surrounding implementation of such strategies by businesses. This knowledge will then be fed in to guidance, skill and knowledge base of surveyors, leading to valid and relevant advice being received by businesses, thus enhancing their adaptation.

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8. References

ABI (2008) Revised statement of principles on the provision of flood insurance. London, Association of British Insurers.

ABI (2009) Preparing the UK for climate change: ABI’s new adaptation strategy London, Association of British Insurers

ABI (2010) Insurers pay out £650 million to help customers weather the coldest winter in thirty years. *ABI News Release.* London, Association of British Insurers.

ADGER, W. N. (2000) Institutional Adaptation to Environmental Risk under the Transition in Vietnam. *Annals of the Association of American Geographers,* 90**,** 738 - 758.

ADGER, W. N. (2003) Social Capital, Collective Action, and Adaptation to Climate Change. *Economic Geography,* 79**,** 387-404.

ALESCH, D. J., HOLLY, J. N., MITTLER, E. & NAGY, R. (2001) Organizations at Risk: What happens when small businesses and not-for-profits encounter natural disasters. *Small*

Organizations Natural Hazards Project, First Year Technical Report, University of Wisconsin-Green Bay. Fairfax, Public Entity Risk Institute.
AXA INSURANCE UK (2008) *Preparing for Climate Change: A Practical Guide for Small Businesses,* London, AXA Insurance UK.
BARDO, J. W. (1978) Organisational response to disaster: A typology of adaptation and change. *Mass Emergencies,* 3**,** 87-104.
BERKHOUT, F., HERTIN, J. & ARNELL, N. (2004) Business and Climate Change: Measuring and Enhancing Adaptive Capacity. *Tyndall Centre Technical Report 11.* Oxford, Tyndall Centre for Climate Change Research.
BICHARD, E. & KAZMIERCZAK, A. (2010) Resilient Homes: Reward-based methods to motivate householders to address dangerous climate change Salford, The University of Salford.
BLEDA, M. & SHACKLEY, S. (2008) The dynamics of belief in climate change and its risks in business organisations. *Ecological Economics,* 66**,** 517-532.
BMG RESEARCH (2011) Cumbria Business Survey 2010 - Research report. Cumbria, Cumbria Intelligence Observatory.
BOSHER, L., CARRILLO, P., DAINTY, A., GLASS, J. & PRICE, A. (2007) Realising a resilient and sustainable built environment: towards a strategic agenda for the United Kingdom. *Disasters,* 31**,** 236-255.
BOWKER, P., ESCARAMEIA, M. & TAGG, A. (2007) Improving the flood performance of new buildings: Flood resilient construction. London, Department for Communities and Local Government.
BROOKS, N. (2003) Vulnerability, risk and adaptation: A conceptual framework. *Tyndall Centre Working Paper No. 38.* Oxford, Tyndall Centre for Climate Change Research.
BROUILLETTE, J. R. & QUARANTELLI, E. L. (1969) Types of Patterned Variation in Bureaucratic Adaptations to Organizational Stress. *Disaster Research Center, Ohio State University, Working Paper 18.* Columbus, Disaster Research Centre, University of Delaware.
CRICHTON, D. (2005) Flood Risk & Insurance in England and Wales: Are there lessons to be learned from Scotland? *Technical paper 01, Benfield Hazard Research Centre.* London, University College London.
CRICHTON, D. (2006) *Climate Change and its effects on Small Businesses in the UK,* London, AXA Insurance UK.
CRICHTON, D. (2008) Role of Insurance in Reducing Flood Risk. *Geneva Papers on Risk & Insurance - Issues & Practice*. Palgrave Macmillan Ltd.
DAHLHAMER, J. M. & D'SOUZA, M. J. (1997) Determinants of business-disaster preparedness in two U.S. metropolitan areas. *International Journal of mass emergencies and disasters,* 15**,** 265-281.
DLUGOLECKI, A. (2008) Climate Change and the Insurance Sector. *The Geneva Papers,* 33**,** 71-90.
EKOS CONSULTING (UK) LTD (2008) Evaluation of Yorkshire Forward's Flood Response. Sheffield, EKOS Consulting (UK) Ltd.
EMISSIONS STRATEGY SOLUTIONS (2011) Business resilience: Engaging SMEs via Accountants - Findings of the 2010/2011 Oxfordshire Trial. Oxford, UKCIP.
ENVIRONMENT AGENCY (2009) Investing for the future: Flood and coastal risk management in England. London, Environment Agency.
GISSING, A., MOLINO, S. & EDWARDS, G. (2005) Business floodsafe - A toolkit for flood preparedness, response and recovery. *Fourth Victorian Flood Management Conference.* Shepparton, Victoria.
GROTHMANN, T. & PATT, A. (2005) Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change Part A,* 15**,** 199-213.
HAIGH, R. P. & AMARATUNGA, D. (2010) An integrative review of the built environment discipline's role in the development of society's resilience to disasters. *International Journal of Disaster Resilience in the Built Environment,* 1**,** 11-24.

JONES, K. & INGIRIGE, B. (2008) Extreme Weather Events and Business Continuity Planning. *CIB W70 International Conference in Facilities Management.* Heriot Watt University, Edinburgh

KREIBICH, H., MULLER, M., THIEKEN, A. H. & MERZ, B. (2007) Flood precaution of companies and their ability to cope with the flood in August 2002 in Saxony, Germany. *Water Resource Research* 43**,** 1-15.

KREIBICH, H., SEIFERT, I., THIEKEN, A., LINDQUIST, E., WAGNER, K. & MERZ, B. (2010) Recent changes in flood preparedness of private households and businesses in Germany. *Regional Environmental Change***,** 1-13.

KREIBICH, H., SEIFERT, I., THIEKEN, A. H. & MERZ, B. (2008) Flood precaution and coping with floods of companies in Germany IN PROVERBS, D., BREBBIA, C. A. & PENNING-ROWSELL, E. (Eds.) *Flood recovery, innovation and response.* Southampton, WIT Press.

LAMOND, J. E. & PROVERBS, D. (2009) Resilience to flooding : learning the lessons from an international comparison of the barriers to implementation. *Urban Design and Planning,* 162**,** 63-70.

MENDELSOHN, R. (2000) Efficient Adaptation to Climate Change. *Climatic Change,* 45**,** 583-600.

MOLINO, S. & GISSING, A. (2005) Lessons from the past are not alway used: Business flood preparedness in two NSW communities. *45th annual conference of the NSW Floodplain Management Authorities,* . Narooma.

NÆSS, L. O., BANG, G., ERIKSEN, S. & VEVATNE, J. (2005) Institutional adaptation to climate change: Flood responses at the municipal level in Norway. *Global Environmental Change Part A,* 15**,** 125-138.

ODPM (2003) Preparing for floods: Interim guidance for improving the flood resistance of domestic and small business properties. London, Office of the Deputy Prime Minister.

PARRY, M. L., CANZIANI, O. F., PALUTIKOF, J. P., LINDEN, P. J. V. D. & HANSON, C. E. (2007) Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, Intergovernmental Panel on Climate Change.

PIELKE, R. A. (1998) Rethinking the role of adaptation in climate policy. *Global Environmental Change,* 8**,** 159-170.

PITT, M. (2008) The Pitt Review - Learning Lessons from the 2007 floods. London, Cabinet Office.

PIVOT, J. & MARTIN, P. (2002) Farms adaptation to changes in flood risk: a management approach. *Journal of Hydrology,* 267**,** 12-25.

SMIT, B., BURTON, I., KLEIN, R. J. T. & STREET, R. (1999) The science of adaptation: A framework for assessment. *Mitigation and Adaptation Strategies for Global Change,* 4**,** 199-213.

SMIT, B., PILIFOSOVA, O., BURTON, I., CHALLENGER, B., HUQ, S., KLEIN, R. J. T. & YOHE, G. (2001) Adaptation to Climate Change in the Context of Sustainable Development and Equity. IN MCCARTHY, J. J., CANZIANI, O. F., LEARY, N. A., DOKKEN, D. J. & WHITE, K. S. (Eds.) *Climate Change 2001: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge Cambridge University Press.

THURSTON, N., FINLINSON, B., BREAKSPEAR, R., WILLIAMS, N., SHAW, J. & CHATTERTON, J. (2008) Developing the evidence base for flood resistance and resilience: R&D Summary Report FD2607/TR1. London, Department for Environment, Food and Rural Affairs (DEFRA).

TIERNEY, K. J. (1994) Impacts of recent disasters on businesses: The 1993 midwest floods and the 1994 northridge earthquake. *Disaster Research Center, University of Delaware.*

TIERNEY, K. J. & DAHLHAMER, J. M. (1996) Business Disruption, Preparedness And Recovery: Lessons From The Northridge Earthquake. *DRC Preliminary Papers, Disaster Research Center, University of Delaware.*

UNISDR (2009) UNISDR Terminology on Disaster Risk Reduction

YOSHIDA, K. & DEYLE, R. E. (2005) Determinants of Small Business Hazard Mitigation. *Natural Hazards Review,* 6**,** 1-12.